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(54) Combining digital video signals

(57) Digital video signals are combined, as are digital key signals, to form composite digital key signals. The apparatus includes a plurality of video layers, wherein each layer is arranged to receive a layer digital video input signal (V1, V2, V3, V4 (Fig 1)) and includes processing means (43, 44, 45, 46) for generating a layer key signal (K1, K2, K3, K4) from said video signal. In addition, combining means (41) are provided for combining the digital video input signals in response to key signals generated by said processing means (43, 44, 45, 46).

A pre-combining means 148, 149, 150, 151 is arranged to receive a video layer signal along with its respective key signal and to receive a new video signal along with its respective new key signal. The pre-combining means pre-combines said layer video signal with said new video signal in response to said layer key signal and said new key signal and supplies a pre-combined video signal with a pre-combined key signal to the combining means (141).

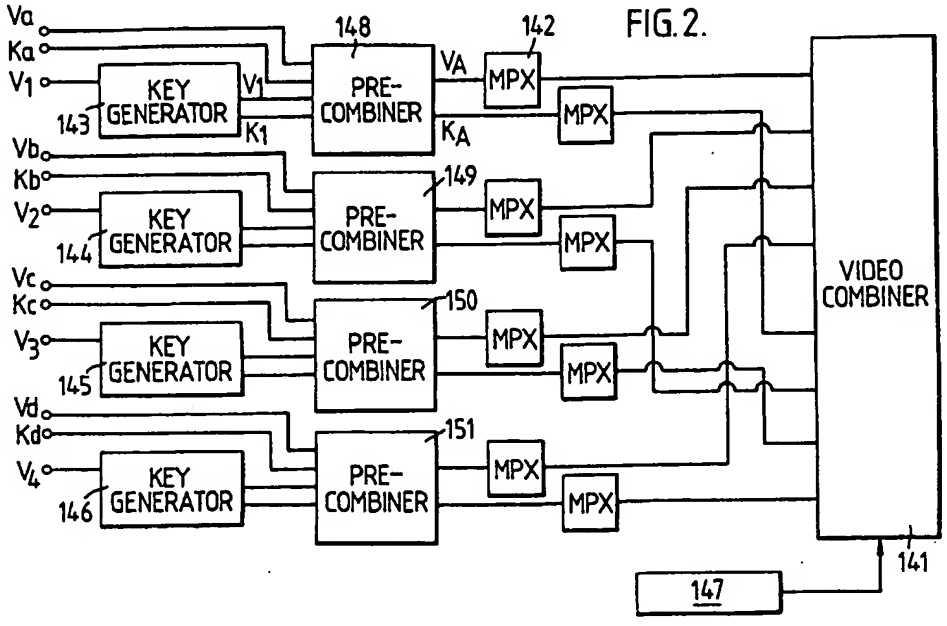

FIG. 2.

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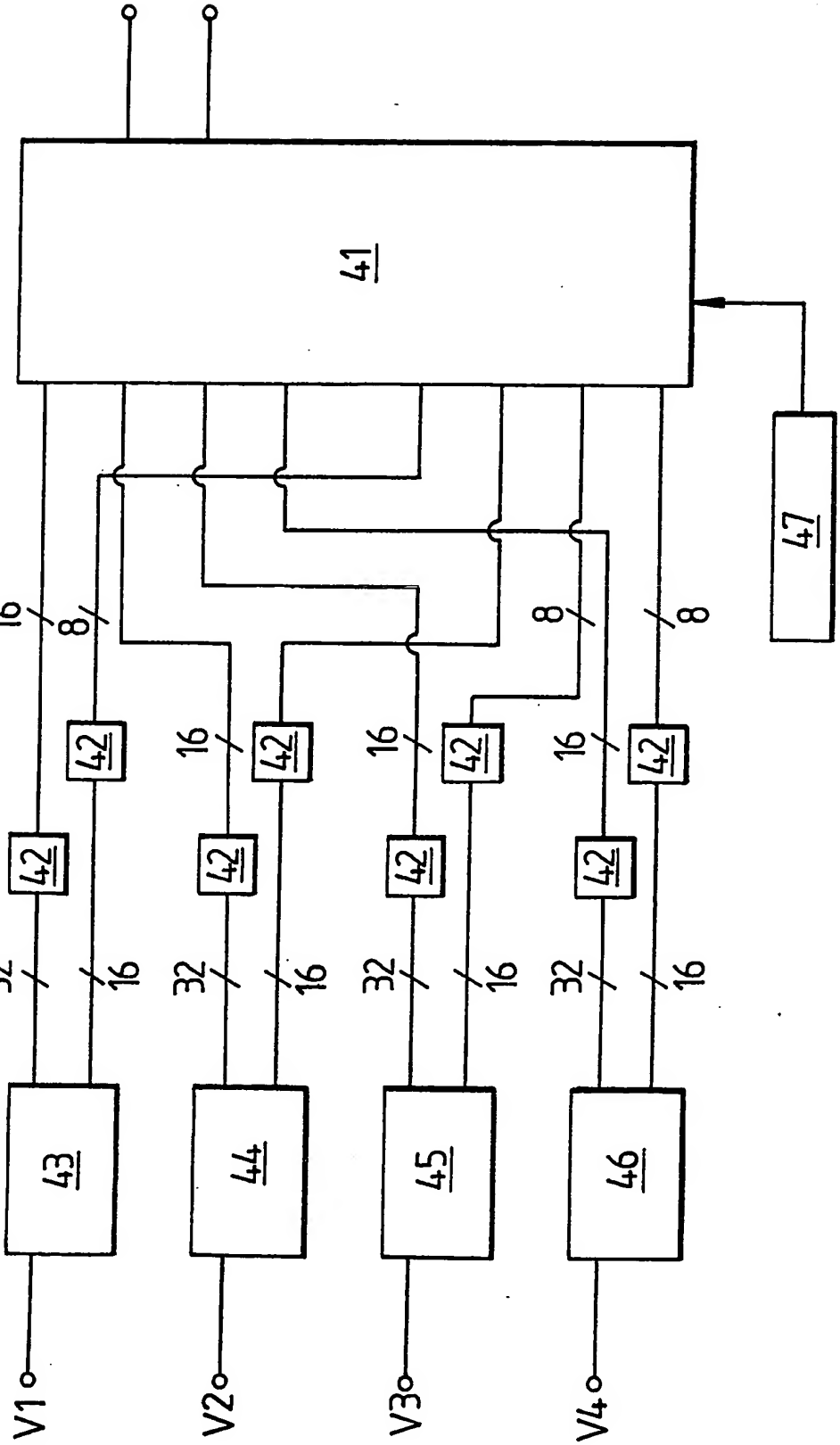
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.


41
47
16
8
8
8
42
42
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42
42
42
42
42
16
16
16
16
32
32
32
32
16
16
16
16
43
44
45
46
V1
V2
V3
V4

FIG. 1.

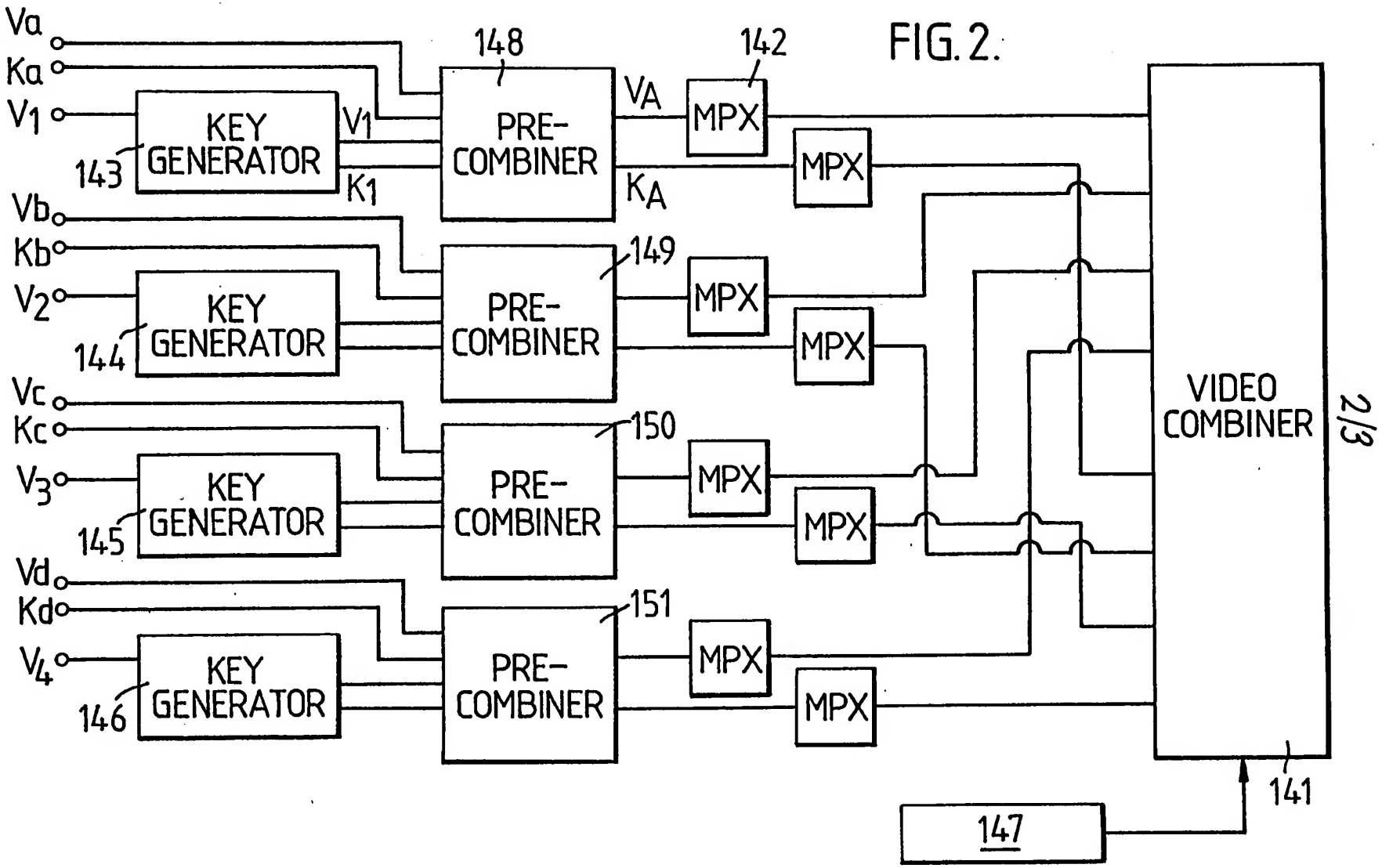
Va
Ka
V1
143
KEY GENERATOR
V1
K1
148
PRE-COMBINER
VA
KA
142
MPX
MPX
Vb
Kb
V2
144
KEY GENERATOR
149
PRE-COMBINER
MPX
MPX
Vc
Kc
V3
145
KEY GENERATOR
150
PRE-COMBINER
MPX
MPX
Vd
Kd
V4
146
KEY GENERATOR
151
PRE-COMBINER
MPX
MPX
VIDEO COMBINER
141
147

FIG. 2.

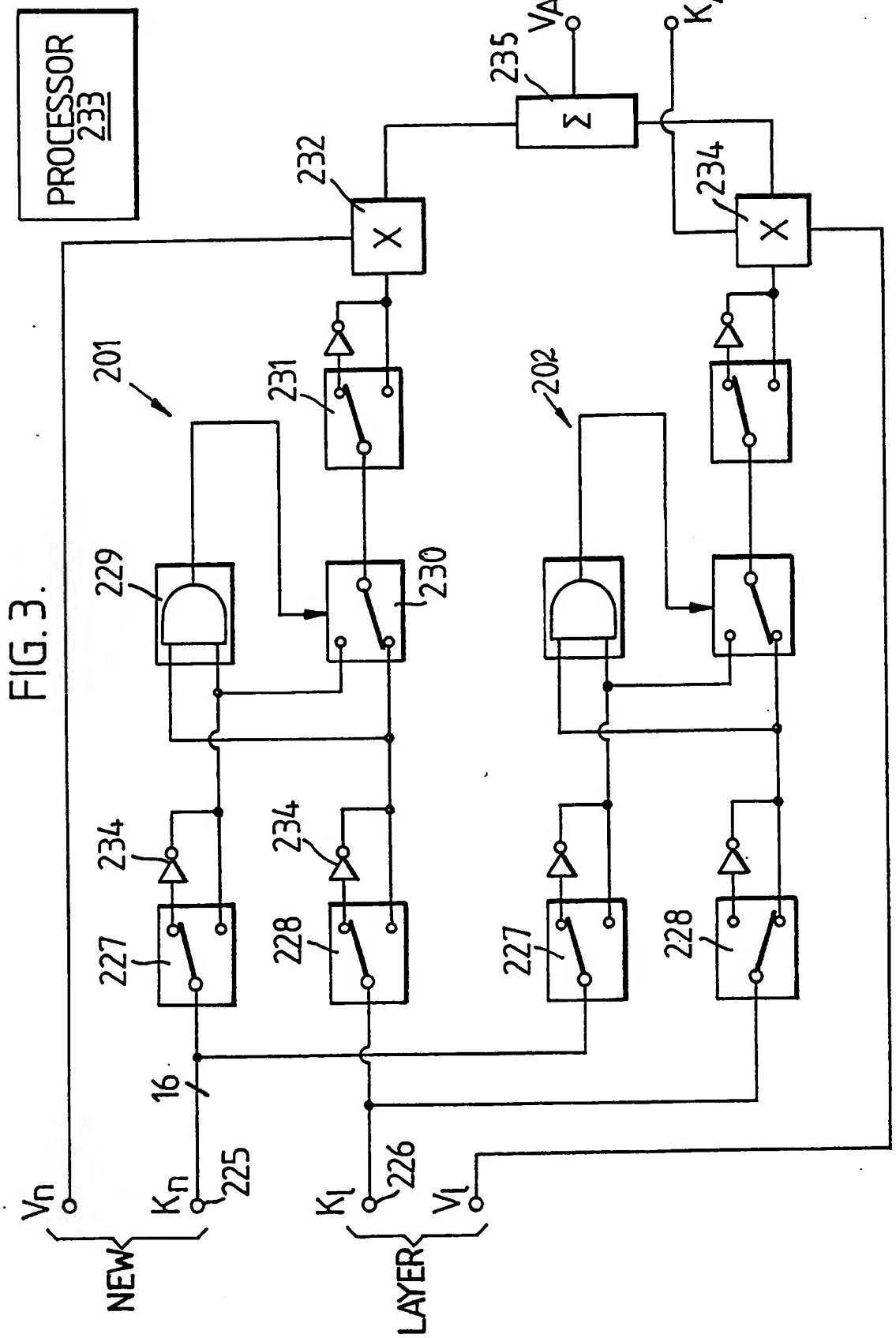
PROCESSOR
233
235
V_A
K_A
Σ
232
234
X
X
201
202
231
229
230
234
234
227
228
227
228
16
225
226
V_n
K_n
K_l
V_l
NEW
LAYER

FIG. 3.

COMBINING DIGITAL VIDEO SIGNALS

The present invention relates to combining digital video signals, in which digital key signals are combined to form composite digital key signals.

Systems are known in which a first video image may be combined with a background video image in real time, to produce a real time output video signal. A known application of this technique involves removing a particular object from a first video image and placing said object against a different background. In order to remove the object, a particular characteristic of the signal representing the object is selected, usually its colour or its brightness, wherein the first of these techniques is referred to as chroma keying and the second is referred to as luminance keying. Thus, in chroma keying, a key signal may be derived from all areas of the picture in which a particular colour is present (usually a saturated blue) and the output signal is produced by adding the two video input signals together, after the background image has been multiplied by the value of the key k and the foreground image has been multiplied by the key value subtracted from unity, 1 - k.

Another example of keying is when a video signal is manipulated by a video effects machine. Such a machine makes the whole video image, rather than selecting a particular object from it and produces an image which is smaller than a full video picture. The manipulated image is, therefore, usually placed against a background image and, in addition to generating the manipulated video image itself, the video effect machine must also generate a key signal, defining the shape of the manipulated image, which may then be used to combine the manipulated image with the background image, using two multiplying stages and an adding stage, as described above.

In recent years, in both television broadcasting and video post production, there has been a move away from conventional analogue processing and towards digital processing. Thus, original video recordings

may be made using a digital format, or photographic film may be converted to digital video and all the mixing and post production manipulations may be performed in the digital domain, thereby allowing many more manipulations to be made, without degrading the integrity of the video signal.

A digital video signal defines an array of discreet picture point data and, unless great care is taken, images may be created which cannot be properly presented by the picture points, resulting in aliasing, more commonly referred to as "jaggies". Thus, for example, key signals may be produced which have very sharp transitions, and, unless said transitions occur in boundaries between adjacent picture points, said transitions cannot be properly represented by the digital signal and undesirable artifacts will be introduced. It is, therefore, well known to produce signals with so-called "soft" edges, in which a transition between two extreme levels occurs over a plurality of picture points, such that a boundary exists over which, rather than a sharp transition occurring between two images, the images are caused to merge together and, although the actual line between the images does not exist, it is perceived by the eye, which then interprets the foreground and background components as being part of the same image.

Systems are also known for combining a plurality of images, in which a second image can be placed over a first, a third over said second, a fourth over said third and so on, however, major difficulties are encountered when combining multiple digital signals in real-time, say, for example, for broadcast purposes.

A particular problem which occurs when combining two partial images together and the combining said partial images against a background, is that a composite key must be produced for keying the previously combined images against the background. A system for combining four digital video signals, which involves generating digital key signals and combining said key signals

to form composite key signals is disclosed in the present applicants co-pending United Kingdom Patent Application (E241) 91 07251-9 the whole contents of which forms part of the present disclosure. A problem with the system disclosed in said co-pending Application is that each input includes processing means for generating a key signal, in response to the applied input video signal. As used herein, each of said channels for receiving a video signal and generating a key signal therefrom, is referred to as a layer, therefore a significant amount of processing hardware is required to generate a layer video signal and, moreover, to generate a layer key signal. Thus, if processing means are provided, such as in the form of a video effects machine which is arranged to generate a key signal, the key signal generating means are duplicated by the layer processing means or, looking at it another way, a whole video layer is taken, which is then not available for other modes of processing. Consequently, using the system disclosed in the aforesaid co-pending Application, in situations where sophisticated apparatus is already producing key signals, expensive layer processing equipment is required which, to a large extent, may be redundant.

It is an object of the present invention to provide an improved apparatus for combining digital video signals.

According to a first aspect of the present invention, there is provided an apparatus for combining digital video signals, in which digital key signals are combined to form composite digital key signals, comprising: a plurality of video layers, wherein each layer is arranged to receive a layer digital video input signal and includes processing means for generating a layer key signal from said video signals; and combining means for combining said digital video input signals in response to key signals generated by said processing means; characterised by pre-combining means arranged to receive a video layer signal along with its respective key signal, and to receive a new video

signal along with a new key signal, wherein said pre-combining means pre-combines said layer video signal with said new video signal in response to said layer key signal and said new key signal and supplies a pre-combined video signal with a pre-combined key signal to said combining means.

The invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a system for combining four video signals, of the type disclosed in the aforesaid co-pending Application, including key generating circuits and a video combining circuit;

Figure 2 shows a similar system to that shown in Figure 1, in which pre-combining means in accordance with the present invention are provided between the key generating circuits and the video combining circuits; and

Figure 3 details one of the pre-combining circuits shown in Figure 2.

A system for combining four video signals and a background signal, of the type disclosed in the applicants aforesaid co-pending Application (E241) as shown in Figure 1. As emphasised in said co-pending Application, an important feature of the system shown in Figure 1 is that the four video input signals may be combined in any order, that is to say, when stacking one signal above the other, any of the four input signals may be placed anywhere within the stack; thus, the video signals have selectable priority. All of the signals are, therefore, made available to a common video combining circuit 41, furthermore, it is also an important feature of the system that it does not degrade the video signal by any noticeable extent, therefore all of the video information is transmitted with thirty two bit definition, at a transmission rate of 13.5 MHz. Thus, in a full colour system, sixteen bits are allocated to the luminance signal and sixteen bits are allocated to the chrominance, that is the u and v signals, furthermore, sixteen bits are also provided for associated key signals. Further, the application of the five thirty two bit video signals, along

with associated key signals, to a common processing environment would be extremely difficult, given the very large number of wires present. Each signal supplied to the combining circuit 41 is, therefore, supplied via a suitable multiplexer 42 which multiplexes the thirty two bit signals at 13.5 MHz to sixteen bit signals at 27 MHz or multiplexes the sixteen bit key signals at 13.5 MHz to eight bit key signals at 27 MHz. The multiplexed signals are then supplied to the combining circuit and de-multiplexed within said combining circuit.

Four real-time video signals V1, V2, V3 and V4 are supplied to respective key generating circuits, along with a background video signal, generated by a background generator 47. Key generating circuits 43 to 46 are detailed in said co-pending Application and may, in addition to providing video input ports, also include key signal input ports, allowing external key signals to be supplied to the system. However, in a system of Figure 1, whenever an external key signal is used, much of the circuitry provided within the respective key generating circuit becomes redundant. Furthermore, if equipment is provided for manipulating a video signal and providing a key signal, the whole video layer of the circuit shown in Figure 1 is taken up, although much of the processing power of the layer is not actually required. Operation of the video combining circuit 41 is also detailed in the aforesaid co-pending Application.

A system for combining digital video signals is shown in Figure 2, which is, substantially, similar to the circuit shown in Figure 1, with the addition of a pre-combiner, embodying the present invention, provided at each video layer, between the key generators 143, 144, 145 and 146. In Figure 2, elements which are substantially equivalent to elements in Figure 1 are given the same reference numeral with one hundred added thereto. It should be noted, that key generator circuits 143 may receive an external key signal, in

which case the means for generating a key signal within said key generator is not employed. However, in the system shown in Figure 2, when a key signal of this type is available, it would normally be supplied to a suitable pre-combiner, thereby enabling the key generation circuit to generate a key from another video source. In Figure 2, each key generator circuit 143 to 146 is shown with its own respective pre-combiner 148 to 151, although, for particular applications, pre-combiners may be provided at selected levels. However, preferably, the invention is embodied at each video level, thereby upgrading the system from one in which four video signals may be combined to a system in which a total of eight video signals may be combined, in addition to a background signal from the background signal generator 147.

Considering one layer, pre-combiner 148 is arranged to receive a video signal v1 and its associated key signal K1 from key generator 143. In addition, the pre-combiner 148 may also receive an external video signal Va with its associated key signal Ka. Thus, video signal V1 requires a key signal K1 to be generated by the key generator but video signal Va already has a key signal Ka which may have been generated, for example, by a video effects machine.

Within pre-combiner 148, video signal V1 may be given priority over the new video signal Va or, alternatively, the new video signal Va may be given priority over the layer video signal V1. The resulting combined video signal VA is then supplied to the video combiner at the layer one input, via a multiplexer 142 and its associated composite key KA is also supplied to said video combiner 141 via a multiplexer 142. Thus, as far as the video combiner 141 is concerned, the composite video signal and its associated key VA and KA is treated in exactly the same way as video signal V1 and its generated key K1 would have been treated, had the pre-combiner 148 not been present.

A pre-combiner, such as devices 148 to 151, is detailed in Figure 3. It should be noted that the video combiner 141 is described in the aforesaid co-pending Application, which describes key combining circuit. It should be noted that the pre-combiners of the type shown in Figure 3 are substantially similar to the key combining circuits used in the video combiner 141. The pre-combiners consist of two key combining units, of the type disclosed in the aforesaid co-pending Application. Referring to key combining unit 201, the digital key signal for the new signal is supplied to an input 225 and the digital key signal from the key generator, i.e. the layer key signal is supplied to an input 226. The key signals are supplied, via respective input inversion switches 227 and 228, to a key comparator 229 and to a key selector 230. The output from said key selector 230 is supplied to an output inversion switch 231, to provide a key output for keying a video signal, by means of a suitable multiplier 232.

Input inversion switches 227 and 228, along with output inversion switch 231, are operated in response to signals from a central control processor 233, such that the key signals produced may be determined in response to signals received from said processor 233. Thus, when placed in their inverting positions, the inversion switches supply signals via respective signal invertors 234, which have the effect of subtracting the signal applied thereto from unity and such signals are distinguished from their non-inverted relatives by using the equivalent signal used for identifying said relatives with a bar placed above said symbol.

The new key signal and the layer key signal are supplied to inputs 227 and 228 respectively of both key combining units 201 and 202, via said input ports 225 and 226. The second key combining unit 202 is substantially similar to key combining unit 201 and also includes an output multiplier 234 for keying a video signal. Thus, the new video signal Vn is supplied to multiplier

232 and the layer video signal is supplied to multiplier 234, the outputs from said multipliers being combined by a video adding device 235, which in turn supplies a video signal to the video combiner 141. In addition to keying the video signal for the layer in multiplier 234, the key signal generated by key combining unit 202 also provides a composite key signal KA for the video combining unit 141.

Thus, the pre-combining circuits provide an elegant modification to a complex system for combining four digital video signals, whereafter said system may be used for combining a total of eight video signals, with a background signal. The use of pre-combiners in the way described is particularly advantageous when the number of layers available is restricted to, say, less than four, such that a relatively modest two layer machine may be used to combine four digital video signals against the background. Obviously, if it is necessary to generate a key signal, the facilities provided by a full layer are required, in particular a key generating circuit, such as circuit 143. However, in many applications, video signals are generated with an associated key, such as the example previously described employing a video effects machine, therefore the inclusion of pre-combining means in accordance with the present invention may provide significant advantages, which greatly extend the operating characteristics of a video combining circuit.

CLAIMS

1. Apparatus for combining digital video signals, in which digital key signals are combined to form composite digital key signals, comprising:

a plurality of video layers, wherein each layer is arranged to receive a layer digital video input signal (V1, V2, V3, V4) and includes processing means (43, 44, 45, 46) for generating a layer key signal (K1, K2, K3, K4) from said video signal; and

combining means (141) for combining said digital video input signals in response to key signals generated by said processing means (43, 44, 45, 46);

characterised by pre-combining means (148, 149, 150, 151) arranged to receive a video layer signal along with its respective key signal, and to receive a new video signal along with a new key signal, wherein said pre-combining means pre-combines said layer video signal with said new video signal in response to said layer key signal and said new key signal, and supplies a pre-combined video signal with a pre-combined key signal to said combining means (141).

2. Apparatus according to Claim 1, wherein a pre-combining means (148, 149, 150, 151) is provided for each of said video layers, thereby doubling the number of video signals which may be combined into the final composite image.

3. Apparatus according to Claim 1 or Claim 2, wherein a pre-combiner combines said new digital key signal and said layered digital key signal to form a composite digital key signal which is supplied to said video combining means; characterised by first selection means (230) arranged to select either a first digital key signal or a second digital key signal in response to a first selection signal, wherein said selection signal becomes the composite key signal; and

first comparison means (229) arranged to produce said first selection signal by comparing the magnitude of said first key signal with the magnitude of said second key signal.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number: 9107893.1

Relevant Technical fields

(i) UK Cl (Edition K) H4F FGH FGJ

(ii) Int Cl (Edition 5) H04N 5/262 5/265 5/272 5/275

Search Examiner: M K REES

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI, INSPEC

Date of Search: 2 DECEMBER 1991

Documents considered relevant following a search in respect of claims 1 TO 3

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB A 2155729 QUANTEL See Figures 2 and 3	1
X	EP A1 0344976 CROSFIELD ELEC. See abstract	1
X	US 4698666 GRASS VALLEY GROUP See abstract	1

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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